310-268

962322
Great Britain

962322 COMPLETE SPECIFICATION

2 SHEETS This drawing is a reproduction of the Original on a reduced scale
Sheets 1 & 2

Fig.1.

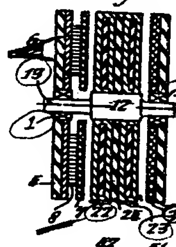

Fig.2.

Fig.3.

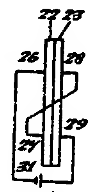

Fig.4.

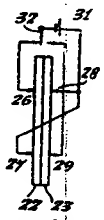

Fig.5.

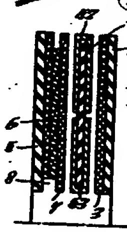

Fig.6.

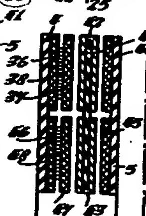

Fig.7.

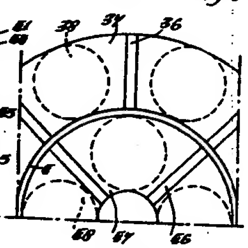

Fig.8.

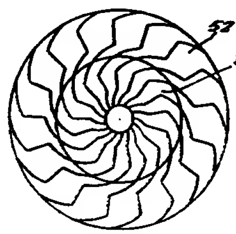

Fig.9.

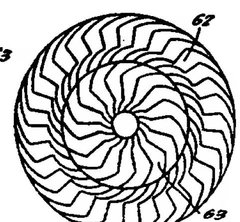

Fig.10.

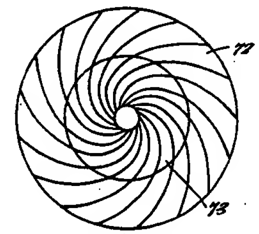

Fig.11.

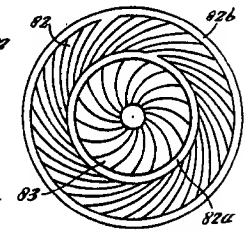

Fig.12.

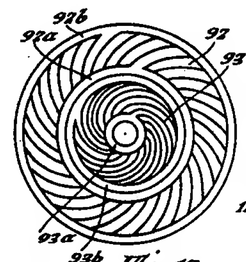

Fig.13.

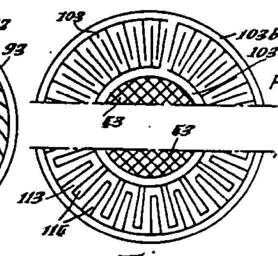

Fig.15.

Fig.14.

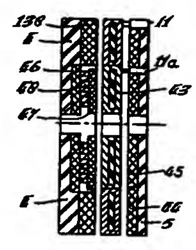

Fig.16.

PATENT SPECIFICATION

962,322

DRAWINGS ATTACHED.

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COMPLETE SPECIFICATION.

Improvements in Dynamo Electric Machines of the Flat Annular Air-Gap Type.

We, SOCIETE D'ELECTRONIQUE ET D'AUTOMATISME, of 138 Boulevard de Verdun, Courbevoie, Seine, France, a Body Corporate, organised according to the laws of France, do hereby declare the invention, for which we pray that a patent may be granted to us, and the method by which it is to be performed, to be particularly described in and by the following statement:—

The present invention relates to improvements in dynamo electric machines of the flat annular air-gap type having discoidal rotor and stator members at least one of which is provided with windings formed of flat conductors applied thereto by a printed circuit technique.

Machines of the above type have been disclosed in the Specification of our Patent No. 874,394. One such machine is of the multipolar type, of which the rotor member carries a plurality of conductors constituting the winding, the winding being formed on a disc by a printed circuit technique its conductors being distributed on both faces of the disc in respective groups and interconnected by interface connections to complete the winding pattern.

A further development of this type of machine as shown in the Specification of our Patent No. 902,295. Whereas in the machine disclosed in Patent No. 874,394, large insulated gaps were left between the printed conductors, the conductors shown in Figure 1 of Patent No. 902,295 are so shaped that only narrow gaps of uniform width less than the conductor widths are left between adjacent conductors. Both the above two types of machines are D.C. machines, brushes being provided to bear against the exposed surfaces of the printed conductors to enable current to be supplied to the rotor when the machine operates as a motor, and to enable current to be collected from the rotor when the machine is driven as a generator.

The application of this type of rotor winding to A.C. dynamo electric machines of the flat annular air-gap type is disclosed in the Specification of our co-pending Application No. 15,583/60 (Serial No. 947,769). A pair of collector rings is provided at the outer periphery of the winding carrier sheet, connections being made between these collector rings and the conductors in the winding for the supply or delivery of current according to whether the machine is to operate as a motor or generator.

According to the present invention there is provided a dynamo electric machine of the flat annular air-gap type having at least one discoidal stator member and a discoidal rotor member, one of which includes a multipolar field magnet structure and the other of which includes at least two separate flat conductor windings formed by a printed circuit technique, the two windings being arranged in co-axial relation with one another, each winding receiving or supplying current through separate sets of brushes.

The present invention will now be described in greater detail by way of example with reference to the accompanying drawings, wherein:—

Figures 1 and 2 show two embodiments of machines having a two-winding rotor member, the windings being stacked or aligned in the axial direction of the machine;

Figures 3, 4 and 5 show examples of electrical circuit connections for the two windings forming part of the rotor member of Figure 1;

Figures 6 and 7 show respective half

cross-sections of further embodiments of machines wherein the two windings are arranged concentrically; the former showing a single field magnet structure for both windings, and the latter showing respective field magnet structures for the two windings;

Figure 8 is a face view of part of the field structure for the machine shown in Figure 7;

Figures 9 to 13 inclusive, show various examples of twin-winding members for the machines of Figures 6 and 7; these patterns differing from one another in the number of conductors, poles, and kind of electrical current (D.C. or A.C.);

Figures 14 and 15 show two embodiments of windings for use with generators of a high frequency electrical current, these Figures showing half-views of the windings; and

Figure 16 shows a generator in which the high frequency windings of either one of Figures 14 and 15 are used.

Referring first to Figures 1 and 2, the machine illustrated includes a rotor having two windings 22 and 23 assembled so that they are stacked or aligned in the axial direction. These two windings are mounted on a hub 12 which in turn is secured to a shaft 13 mounted between bearings 1. The machine also includes two stators which are positioned on either side of the rotor. One stator includes a number of pairs of magnetic poles 8, provided with pole shoes 7 and mounted on an annular ring 6 made of magnetic material. The annular ring 6 is itself secured to a mounting plate 4. The second stator comprises solely of magnetic yoke 3 secured to a mounting plate 5. The rotor windings 22 and 23 are either secured to each side of an insulating ring 24, (Figure 1) or are secured on each side of a magnetic supporting ring 25 (Figure 2).

Referring to Figure 3, these windings are separately energizable by separate pairs of brushes 26, 27 for the winding 22 and 28, 29 for the winding 23. When the winding 22 is supplied with current there is produced across the brushes of the winding 23 an induced voltage which may be used either as a tachometric signal for measuring the speed of rotation of the machine, or for the supply of a load. This may be done for D.C. as well as for A.C. machines, and the input may be either A.C. or D.C. and the output either D.C. or A.C., The machine can therefore act as a motor from its input, and as a generator, for its output.

When the rotor is driven, two separate currents are generated in the windings 22 and 23. Since the number of conductors may be different these currents need not be equal.

When the machine is used as a motor, it can be run at three different speeds; one when only the winding 22 is fed with current, a second when only the winding 23 is fed with current, and a third when both windings 22 and 23 are fed with current. Denoting U_1 as the voltage across 26, 27, and U_2 as the voltage across 28, 29, these three speeds have the respective values K/U_1, K/U_2 and $K/(U_1 + U_2)$, where K is a constant.

Referring to Figure 4, the two windings are connected in series so that when a single supply source 31 is used, the operating voltage can be increased. In another embodiment shown in Figure 5, the two windings are energized via a change-over switch 32 which controls the rotation either in a forward or reverse direction according to which winding 22 or 23 receives the energizing current.

It is obvious that such a stacked arrangement shown in Figures 1 or 2 may be enlarged to include more than two windings provided that the inner windings in the stack extend radially beyond the outer windings so that brushes can make contact with the inner winding in the case of the rotor. Although the number of conductors and even the types of winding patterns can be varied, this arrangement does not enable any flexibility in relation to the choice in the number of poles from winding to winding.

On the other hand, where the twin-winding member is formed with the windings arranged in concentric relation it is possible to vary the number of poles between the windings. Furthermore the concentric arrangement has the additional advantage over the axially stacked type in that the air-gap is not unduly widened between the magnetic members in the machine and in that the efficiency which is slightly reduced in the stacked arrangement, is not reduced at all.

Concentric windings are shown in Figures 6 and 7 at 42 and 43. The windings are formed on the radially outer and inner annular portions of a single annular carrier 41. In Figure 6 the two windings co-operate with a single field magnet structure like that of Figure 1, and each pole shoe 7 occupies radially the same span as both spans of the concentric windings 42 and 43. In Figure 7, two distinct field magnet structures 36, 37, 38, 44 and 46, 47, 48, 45 respectively co-operate with the windings 42 and 43. In this field magnet structure, pole pieces 38 and 48 are mounted on magnetic rings 36 and 46 respectively and are provided with sector shaped shoes 37 and 47. Magnetic rings 44 and 45 serve the same functions as the ring 3 in the embodiment of Figure 1. The concentric winding arrangement is quite an advantage where the windings perform distinct operations in the machine, since it is possible to provide different numbers of

magnetic poles for the different windings. Preferably, in such a case the number of poles will be made higher in the outer ring than in the inner ring. Figure 8 shows part of a field magnet structure which has four poles in the inner ring and eight poles in the outer ring.

Figure 9 shows a front view of a rotor having two concentric windings 52 and 53 for an eight pole machine, with seventeen turns. Figure 10 shows a front view of a rotor having windings 62 and 63 which have different numbers of conductors for the same number of poles. Figure 11 shows a rotor having a four pole winding 73 and an eight pole winding 72. The above examples are given purely by way of example it being appreciated that many other arrangements are possible. They relate to D.C. machines.

Figure 12 shows an example of a machine having a rotor the inner winding 83 of which is a D.C. winding and the outer winding 82 is an A.C. winding having inner and outer collector rings 82*a* and 82*b* respectively. Figure 13 shows a rotor having both an A.C. inner winding 93 with collector rings 93*a* and 93*b* and an outer A.C. winding 92 with collector rings 92*a* and 92*b*. The winding 93 is a four pole winding and the winding 92 is a sixteen pole winding.

As mentioned above, windings made in accordance with the invention may be incorporated in A.C. generators for generating a high frequency current at a moderate speed. It is then advantageous to construct the outer winding patterns with closely spaced sector shaped turns forming one complete winding of zig-zag shape on each face of the insulating carrier. This may be done irrespective of the winding pattern of the inner winding 43 (Figures 14 and 15). In Figure 14 the conductive zig-zag is shown at 113 and the intervals which separate the adjacent radial portions of the turns of the zig-zag are shown at 114. These intervals 114 may be filled with magnetic material secured to the insulating carrier to a depth which makes them level with the copper of the turns. For a higher number of poles, or a smaller diameter of the ring, the zigzag winding may occupy almost the whole surface of the outer part of the carrier, thereby reducing the intervals 114 to narrow gaps or slits. Such a zig-zag winding is shown at 103 in Figure 15.

Figure 16 shows a cross-sectional view of a generator having a rotor member of the type such as those shown in Figures 14 and 15. Preferably, the field magnet structure for the outer winding consists of a ferrite ring 138 upon which magnetic poles have been induced by means of a well known process of magnetization. In this way it is possible to produce a field magnet structure having substantially any desired number of poles. For example, one pole per zig-zag of the winding. Two brush holders 11 (only one of which is shown) are provided for brushes which bear on the collector rings 103*a* and 103*b*, (Figure 15). Two brush holders 11*a*, (only one of which is shown) are provided for brushes which bear on the inner winding 43.

Twin-winding machines as described above have the following advantages:—

1. Increase of the power of the machine by connecting the windings in series;
2. Easy control of the direction of rotation of the machine, through a selective energization of the windings;
3. Direct display and measurement of the speed of the machine, by using one of the windings as a tachometer winding;
4. Adjustable speed control of the machine through energization of the windings in various combinations;
5. Production of electrical rotary converters (including D.C. to D.C.; A.C. to A.C.; D.C. to A.C. and A.C. to D.C.).

All these features are not necessarily obtained when the twin-windings are axially aligned but all of them can be obtained when the twin-windings are concentrically mounted. Other combinations of these features may be obtained by providing the twin-winding member with both axially aligned windings and concentrically arranged windings.

Attention is drawn to the Specification of our Patent No. 931,654, in which there is claimed (in Claim 1) a winding for an electrical rotating machine of the flat annular air-gap type, said winding being distributed over both faces of a thin insulating disc in two sets of half-turn conductors and formed thereon by a printed circuit technique, the sets of half-turn conductors being interconnected at their inner and outer ends by face-to-face connections to form the winding pattern, the conductors each including active portions having at each end inclined extensions which approach the inner and outer peripheries of the disc, wherein the active portions are also inclined to the radial direction of the disc.

WHAT WE CLAIM IS:—

1. A dynamo electric machine of the flat annular air-gap type having at least one discoidal stator member and a discoidal rotor member, one of which includes a multipolar field magnet structure and the other of which includes at least two separate flat conductor windings formed by a printed circuit technique, the two windings being arranged in co-axial relation with one another, each winding receiving or supplying current through separate sets of brushes.

2. A machine according to Claim 1,

wherein said two windings are axially aligned.

3. A machine according to Claim 1, wherein said two windings are arranged in concentric relation in the same plane, one within the other.

4. A machine according to any one of the preceding claims, wherein the two windings have the same number of conductors.

5. A machine according to any one of the preceding Claims 1 to 3, wherein the two windings have a different number of conductors.

6. A machine according to any one of the preceding claims, wherein the two windings are of the same electrical type, viz:—either D.C. or A.C.

7. A machine according to any one of the preceding Claims 1 to 5, wherein one of said windings is A.C. and the other is D.C.

8. A machine according to Claim 3, wherein the two windings co-operate with the single field magnet structure.

9. A machine according to Claim 3, wherein the two windings co-operate with respective concentric field magnet structures,

10. A machine according to Claim 9, wherein the two field magnet structures have different numbers of magnetic poles.

11. A machine according to Claim 9, wherein the outer winding consists of two windings, one on each face, each winding having closely spaced sector shaped turns forming a winding of zig-zag shape.

12. A machine according to Claim 11, wherein one field magnet structure has as many poles as there are turns in the winding.

13. A machine according to Claim 1, wherein at least two winding members each including two co-axially arranged windings are axially aligned in a unitary structure.

14. A machine according to Claim 13 and comprising at least two aligned two-winding members, wherein the diameter of one member is greater than that of the other to enable engagement by brushes.

15. A dynamo electric machine of the flat annular air-gap type constructed and arranged to operate substantially as herein described with reference to and as illustrated in the accompanying drawings.

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